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# Physical Fitness Predictors of Success and Injury in Ranger Training

William P. Burke and Frederick N. Dyer

ARI Field Unit at Fort Benning, Georgia  
Training Research Laboratory

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February 1984

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rate measurement following the Harvard Step Test. Elimination from the course for medical reasons also was associated with one heart rate measurement from the Step Test.



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Research Report 1366

# Physical Fitness Predictors of Success and Injury in Ranger Training

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## FOREWORD

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Part of the on-going research program on soldier performance is concerned with how physical fitness affects soldiers' performance in combat situations. This particular effort was completed in support of the U.S. Army Infantry School, which is the proponent for physical training programs in the Army. This report describes research exploring the relationship between the physical fitness of Ranger students and graduation from the Ranger Training Course. In addition, it presents data bearing on the relationship between physical fitness and the occurrence of injuries during training.

The major finding of this research is that soldier fitness is an important determinant of Ranger training success. The results will be of particular interest to the Ranger Department at Fort Benning, Georgia, and to other military organizations that provide rigorous physical training to their members.



EDGAR M. JOHNSON  
Technical Director

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## PHYSICAL FITNESS PREDICTORS OF SUCCESS AND INJURY IN RANGER TRAINING

### EXECUTIVE SUMMARY

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#### Requirement:

To document the effects of physical fitness on Ranger Course performance and to test the hypothesis that physical fitness is related to the occurrence of injury during training.

#### Procedure:

On the day before training began during FY 1979, each of 906 students from six classes of the Ranger Course at Fort Benning, Georgia, completed a background information questionnaire that included questions about the individual's most recent scores on the Advanced Physical Fitness Test (APFT). At that time, each student also underwent a physical fitness test specially designed by the Army Research Institute (ARI). The test consisted of a modified Harvard Step Test plus both push-ups and chin-ups. The Harvard Step Test yields measures of cardiovascular fitness in terms of heart rate after exercise; push-ups and chin-ups are measures of upper-body strength.

Data regarding the occurrence of injuries during training were gathered primarily from the Ranger students, who filled out confidential injury questionnaires after each phase of training. These questionnaires asked for a description of injuries sustained during training that were not serious enough to cause permanent elimination from the course. Reports of all injuries and illnesses serious enough to cause the student to be dropped from the course were taken from official Disposition Forms of the Ranger Department.

#### Findings:

The results showed that performance in all events of the APFT except Run, Dodge, and Jump was related to performance in Ranger training. In addition, heart rate following both the slow and the fast cadence stepping of the Harvard Step Test was related to training success, as were push-ups and chin-ups.

The occurrence of nonserious injuries during training was related both to physical fitness scores in several events of the APFT and to one of the heart rate measurements following the Harvard Step Test. Elimination from the course for medical reasons was related to one of the heart rate measurements from the Step Test, but not to APFT scores.

#### Utilization of Findings:

These results bear on the selection of students for the Ranger Training Course. The data will be used to set the most appropriate entry level of physical fitness to ensure that the students selected to attend are fully prepared for the physical demands to be placed upon them. The results of this research also will be of interest to all other military organizations that provide rigorous physical training to their members.

# PHYSICAL FITNESS PREDICTORS OF SUCCESS AND INJURY IN RANGER TRAINING

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# PHYSICAL FITNESS PREDICTORS OF SUCCESS AND INJURY IN RANGER TRAINING

## INTRODUCTION

For several years, the U.S. Army has been involved in an extensive re-evaluation of its program of physical fitness training, including revisions of its fitness test standards for entry of soldiers into various training courses. This process is critically important for the continued success of training programs, such as the Ranger Course at Fort Benning, Georgia. Such programs are physically demanding and require students to report in at sufficiently high levels of physical fitness to endure the rigors of the training.

The Ranger Course is intended to develop leadership skills in its students "by requiring them to perform effectively as small unit leaders in a realistic tactical environment, under mental and physical stress approaching that found in combat" (Ranger Department, 1980, p. 6). The training lasts for 58 days, with an average of 18 hours of training each day, 7 days a week. During that period, the students participate in extensive patrolling operations in forest, mountain, jungle, and swamp terrain. In addition, they learn and employ mountaineering and stream-crossing techniques. Most execute a series of parachute jumps. In the course of the training, students encounter physical stresses that include heat, cold, hunger, fatigue, and extended sleeplessness that often lead to states of near-exhaustion (Ranger Department, 1980, p. 6).

As might be expected, the cadre of the Ranger School believes that there is a strong relationship between performance in the strenuous and exhausting Ranger training program and the physical fitness levels of students when they begin the course. In addition, the cadre generally believes that the state of students' physical fitness determines their susceptibility to injury during training. At the time of this research, there was no scientific evidence to support either proposition. In view of the on-going effort to revise the physical fitness test measures and standards through which the Ranger School selects its students, it was important to document the effect of physical fitness on success in Ranger training and to test the hypothesis that physical fitness and the occurrence of injuries are related. The data from this research could be used by the Ranger Department to evaluate its need for rigorous physical fitness testing and to set the appropriate entry level criteria to ensure that entering students are fully prepared for the physical demands they will face in training.

## OBJECTIVES

The objectives of this research were to document the effects of physical fitness on Ranger Course performance and to test the hypothesis that level of physical fitness is related to the occurrence of injuries during training.

## METHOD

### General

The data were collected from six classes of Ranger students in FY 1979: Classes 501, 502, 503, 504, 506, and 507. On Inprocessing Day of these classes data collectors asked students to provide their most recent scores on the Advanced Physical Fitness Test (APFT).<sup>1</sup> They also administered to each class a physical fitness test specially designed by the Army Research Institute (ARI). This test consisted of a modified Harvard Step Test supplemented by both push-ups and chin-ups.

### Advanced Physical Fitness Test

As the records containing their actual scores were not available to the students at Fort Benning, they were asked to produce from memory the number of points out of a possible 100 that they scored on each event of the Advanced Physical Fitness Test. Those events are Inverted Crawl; Sit-ups; Horizontal Ladder; Run, Dodge, and Jump; and the 2-Mile Run.

Points scored became the measure of choice as staff felt that students could more accurately remember points than actual times or repetitions done on a test that, by then, they might have completed months earlier. An unanticipated and undesirable consequence of this decision to use point scores was the finding that a large number of individuals achieved scores of 100 in many events. This, in effect, created a ceiling above which point scores could not vary even though the actual raw scores differed. There was no way to distinguish relative levels of physical fitness of those many individuals who scored 100.

### Army Research Institute Physical Fitness Test

Cardiovascular Fitness Measure--The Modified Harvard Step Test. The data relating to cardiovascular fitness for this research came from a modified Harvard Step Test. The step test procedure used was the modification by Tuxworth and Shahnawaz (1977), which has produced correlations in the high 80s between heart rate (adjusted by weight) and physical work capacity (max  $\text{VO}_2$ ) as measured by bicycle ergometry. The Modified Step Test consisted of two 5-minute periods of stepping up and down on a 16-inch bench, first at a slow cadence (15 steps per minute) and then, following an approximate 10-minute rest, at a fast cadence (25 steps per minute). The students worked in pairs, with one stepping while the other rested. After each period of stepping, each student sat down on the bench while the paired counterpart measured the stepper's heart rate from the carotid artery under the jaw. The first measurement was taken 30 seconds after the end of each stepping period, the next measurement 90 seconds after, and the final one 150 seconds later.

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<sup>1</sup>Soon after this research was completed the Army revised its physical fitness test; Inverted Crawl, Horizontal Ladder, and Run, Dodge, and Jump are no longer used.

Strength Measures--Push-ups and Chin-ups. The upper-body strength measures taken in this research were the number of repetitions of push-ups completed in a 1-minute period and the number of repetitions of chin-ups completed in a 1-minute period.

Following U.S. Army regulations (FM 21-20, 1973), individuals were to do the push-ups in such a manner that their chests touched the ground on the downward movement and were to do chin-ups with the palms of their hands facing toward their bodies and in such manner that their chins topped the bar at the high point of the chinning maneuver. Students performed the Step Test first, followed by push-ups and chin-ups.

Injury Data. Data regarding the occurrence and nature of injuries during training were gathered primarily from the Ranger students themselves, who filled out confidential injury questionnaires (see Appendix A) after each phase of training. This questionnaire asked for a description of injuries that the students might have sustained in training but that were not serious enough to cause them to be dropped permanently from the course. Reports of all serious injuries were taken from official Disposition Forms of the Ranger Department.

Procedure. The administration of the ARI Physical Fitness Test for each class of students took place on Inprocessing Day, the day before the beginning of actual training. At that time, staff took students in groups of approximately 32 each to an enclosure containing two benches for the Step Test and horizontal bars for chin-ups.

Staff told students the purpose of the experiment and asked them to volunteer. Staff explained that the data taken in the experiment would be used to help the Ranger Department decide on the physical fitness levels to require of future Ranger students. Students were strongly encouraged to do their very best on the test so that the data would represent their true physical fitness levels rather than their motivation level. The latter outcome, it was explained, would confound the results and make them useless.

Students were then broken down into two smaller groups of approximately 16 each and every student in one group was assigned a partner in the other group. From then on, each pair worked as a team so that, while one person exercised, the other stood by to measure the exerciser's pulse during the Step Test and to count the repetitions of chin-ups and push-ups performed.

The Step Test procedure was conducted first, and one 16-student group was tested on two benches with approximately 8 students to a bench. The test was conducted for both groups in the manner described earlier.

At the conclusion of the Step Test, the entire 32-student group was given a 3-minute rest. Then the 16-student group that had been first to finish the Step Test was asked to perform all the push-ups possible in a 1-minute period. As soon as the first group finished, the second group performed the push-ups.

After a rest of 3 minutes following the last push-ups, the group that was first to finish push-ups began the chin-ups. For this exercise, only



8 individuals at a time could perform. Each did all the chin-ups possible in a 1-minute period. The second 16-student group followed, 8 at a time.

Data Analysis. The primary method of statistical analysis chosen for these data was chi-square, a test of statistical significance used to determine whether a systematic relationship exists between two variables (Nie et al., 1975). The particular characteristics of the physical fitness point score data of this research led to selection of this procedure. Because the selection of Ranger students is based in part on high fitness point scores, the distribution of scores is skewed, that is, most students show scores in the high range. A second important characteristic of the data is the 100-point ceiling of fitness scores (referred to earlier) that causes individuals of unequal levels of fitness to be grouped together as maximum performers. Thus, the range of possible scores is severely restricted at the low fitness and at the high fitness ends of the distribution.

These undesirable characteristics of the data and a resulting uncertainty about the precision of measurement involved prompted grouping of scores into 10-point categories (described more fully below). With the scores grouped in this manner, the chi-square test could compare the frequencies of Ranger School graduates and nongraduates appearing in each fitness point category to the frequencies to be expected if no relationship existed between physical fitness and graduation. This comparison allows a determination of the probability that the scores obtained by graduates and nongraduates in each fitness category could have occurred by chance, that is, whether the variables under study are independent or related.

In order to determine the strength of any relationships found to exist, Cramer's  $V$  (Nie et al., 1975) was calculated for the data from each chi-square. Like Pearson's  $r$ , Cramer's  $V$  takes the value 0 when no relationship exists and a value of 1 when the variables are perfectly related.

## RESULTS

### Class and Graduate Status

Table 1 shows the percentages of graduates by class for the six classes involved in this research. The graduating percentages ranged from 57.0% to 77.9%. These figures reflect only the fact that the nongraduates failed to graduate with their original classes and take no account of the frequent recycling of individuals and their eventual graduation with a later class.

### Disposition and Graduate Status

Table 2 shows the disposition of all individuals who enrolled in the course during this research. The table demonstrates that over two-thirds (68%) of the students passed while the remainder failed to complete the course for various reasons.

The largest category of those who did not graduate was composed of individuals who were dropped from the rolls for medical reasons (14.3%). The next largest category consisted of those who failed for various training

deficiencies, including inability to complete physical fitness activities, such as runs of various distances (12.6%). This was followed by a lack-of-motivation category comprising all those who declared themselves unwilling to continue training.

Table 1

Percentage of Graduates and Number Enrolled by Class

Ranger class	Percentage of graduates	Number enrolled
Unknown	52.0	171
502-79	57.0	121
2-79	67.4	129
3-79	66.0	141
4-79	57.7	142
6-79	57.0	107
7-79	77.9	95
Total		906

Table 2

Disposition of Enrollees by Number and Percentage

Disposition	Number	Percentage of total enrollment
Pass	616	68.0
Administrative Drop	3	0.3
Medical Drop	130	14.3
Fail--Training Deficiencies	114	12.6
Fail--Lack of Motivation	37	4.1
Other	6	0.6
Total	906	99.9

Physical Fitness Test Variables and Graduate Status

Advanced Physical Fitness Test. Tables 3 through 8 set forth the percentage of graduates from the Ranger Course of groups of students classified according to how many points they scored overall and in each event of the APFT. In the tables the scores for each event are blocked into 10-point categories ranging from the 50-59 point category to the 100-point, perfect score, category.

Table 3

Percentages of Graduates and Nongraduates as a Function of Score Level on the Inverted Crawl<sup>a</sup>

Graduate status	No scores	Level of performance*					
		50-59 points	69-69 points	70-79 points	80-89 points	90-99 points	100 points
Percentage of graduates	58.1 (250)	0.0 (0)	40.0 (4)	42.9 (18)	64.8 (92)	68.7 (112)	67.5 (79)
Percentage of nongraduates	41.9 (180)	100.0 (2)	60.0 (6)	57.1 (24)	35.2 (50)	31.3 (51)	32.5 (38)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square,  $df = 6$ ;  $p = .004$ . Cramer's  $v = .146$ .

Table 4

Percentages of Graduates and Nongraduates as a Function of Score Level on Sit-ups<sup>a</sup>

Graduate status	No scores	Level of performance*						
		40-49 points	50-59 points	60-69 points	70-79 points	80-89 points	90-99 points	100 points
Percentage of graduates	57.0 (244)	100.0 (1)	0.0 (0)	41.7 (5)	57.4 (27)	60.6 (66)	62.6 (112)	76.9 (100)
Percentage of nongraduates	43.0 (184)	0.0 (0)	0.0 (0)	58.3 (7)	42.6 (20)	39.4 (43)	37.4 (67)	23.1 (30)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square,  $df = 6$ ;  $p = .003$ . Cramer's  $v = .148$ .

Table 5

Percentages of Graduates and Nongraduates as a Function of  
Score Level on the Horizontal Ladder<sup>a</sup>

Graduate status	No scores	Level of performance*					
		50-59 points	60-69 points	70-79 points	80-89 points	90-99 points	100 points
Percentage of graduates	57.6 (293)	100.0 (1)	50.0 (9)	56.8 (46)	71.3 (87)	68.6 (70)	67.1 (49)
Percentage of nongraduates	42.4 (216)	0.0 (0)	50.0 (9)	43.2 (35)	28.7 (35)	31.4 (32)	32.9 (24)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square, df = 6; p = .032. Cramer's v = .123.

Table 6

Percentages of Graduates and Nongraduates as a Function of Score Level on Run, Dodge, and Jump<sup>a</sup>

Graduate status	No scores	Level of performance*							
		30-39 points	40-49 points	50-59 points	60-69 points	70-79 points	80-89 points	90-99 points	100 points
Percentage of graduates	57.9 (254)	100.0 (1)	0.0 (0)	0.0 (0)	16.7 (1)	70.6 (36)	66.9 (83)	62.6 (122)	65.2 (58)
Percentage of nongraduates	42.1 (185)	0.0 (0)	100.0 (1)	0.0 (0)	83.3 (5)	29.4 (15)	33.1 (41)	37.4 (73)	34.8 (31)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.\*Significance: chi-square,  $df = 7$ ;  $p = .058$ . Cramer's  $V = .123$ .

Table 7

Percentages of Graduates and Nongraduates as a Function of  
Score Level on the 2-Mile Run<sup>a</sup>

Graduate status	No scores	Level of performance*				
		60-69 points	70-79 points	80-89 points	90-99 points	100 points
Percentage of graduates	56.7 (246)	69.2 (9)	43.8 (14)	47.9 (23)	64.8 (103)	72.7 (160)
Percentage of nongraduates	43.3 (188)	30.8 (4)	56.3 (18)	52.1 (25)	35.2 (56)	27.3 (60)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square, df = 5; p < .001. Cramer's V = .166.

Table 8

Percentages of Graduates and Nongraduates as a Function of Level of Total Score on the APFT<sup>a,b</sup>

Graduate status	No scores	Level of performance*									
		50-99 points	100-149 points	150-199 points	200-249 points	250-299 points	300-349 points	350-399 points	400-449 points	450-499 points	500 points
Percentage of graduates	56.8 (235)	66.7 (2)	83.3 (5)	40.0 (2)	100.0 (6)	50.0 (4)	52.5 (21)	61.1 (33)	59.9 (91)	71.2 (148)	80.0 (8)
Percentage of nongraduates	43.2 (179)	33.3 (1)	16.7 (1)	60.0 (3)	0.0 (0)	50.0 (4)	47.5 (19)	38.9 (21)	40.1 (61)	28.8 (60)	20.0 (2)

<sup>a</sup>Advanced Physical Fitness Test.<sup>b</sup>Numbers in parentheses are the numbers enrolled from each group.\*Significance: chi-square,  $df = 10$ ;  $p = .018$ . Cramer's  $V = .154$ .

The column headed "No Scores" shows the percentage of individuals who could not remember (or would not divulge) their scores on the particular event named.

As the tables show, for most events--Crawl, Sit-up, 2-Mile Run, and Total Score--the percentage of graduates increases as the point score increases. That outcome in each event is significantly different from what would be expected by chance alone. In the two remaining events--the Horizontal Ladder and Run, Dodge, and Jump--the percentage of graduates peaks in the midrange of scores and, in general, declines slightly toward the upper range. Results for the Horizontal Ladder are statistically significant, but those for Run, Dodge, and Jump are just short of the traditionally accepted .05 level of significance to rule out chance.

Inspection of the value of Cramer's  $V$  statistic in Tables 3 through 8 reveals that the strength of the relationship between fitness level and graduate status varies from .123 to .166. Although these relationships are not strong, it should be recalled that students must have met specific physical fitness levels on the basis of their APFT scores prior to their selection for the Ranger Course. As a result, all incoming students are physically fit relative to the population from which they are chosen. This ensures that obtained correlations between the attenuated variable of physical fitness and training outcomes will necessarily underestimate the strength of the true relationship.

Army Research Institute Physical Fitness Test. Tables 9 through 12 follow the same format as the preceding tables except that the score categories are based on heart beats per half-minute for the Step Test and numbers of repetitions per minute for push-ups and chin-ups. The array of scores in these tables differs most radically from the preceding scores in that the highest levels of physical fitness on the Step Test measures are represented by the lowest heart rate categories, as listed on the left side of the table. In the push-ups and chin-ups measures the reverse is true, with higher scores representing higher levels of fitness.

Since the results from each heart rate measurement during the Step Test (30 seconds, 90 seconds, and 150 seconds after stepping) were essentially the same, Tables 9 and 10 set forth the results of only the 30-second measurement after both the fast and slow cadence stepping periods.

Examination of the tables reveals that, for all groups for which there are more than a handful of individuals represented, the percentage of graduates increases as fitness increases. The single exception is in the 70-79 push-ups per minute category in Table 11. This column shows a considerable drop in percentage of graduates, 66.7%, from that of the less physically fit group who performed 60-69 push-ups per minute but of whom 76.5% graduated. This result may well have resulted from the ease of cheating when performing push-ups. Individuals who perform the push-ups improperly by not lowering themselves far enough toward the ground are able to do more repetitions than they otherwise could, and thus they appear to be in better physical condition than they actually are. Consequently, a measure of their true abilities might place them in one of the less fit categories of Table 11.

All the distributions in the tables are highly significant, well beyond chance expectation, and thus most probably reflect the "true" relationship between physical fitness and graduation status from Ranger School. The



Table 9

Percentages of Graduates and Nongraduates as a Function of Heart Rate Levels Following the Harvard Step Test, Slow Cadence<sup>a</sup>

Graduate status	Not tested	Heart rate* (beats/half-minute after 30 seconds rest)						
		20-29	30-39	40-49	50-59	60-69	70-79	80-89
Percentage of graduates	50.4 (128)	100.0 (1)	78.9 (30)	73.6 (109)	65.4 (161)	63.2 (115)	25.8 (8)	50.0 (3)
Percentage of nongraduates	49.6 (126)	0.0 (0)	21.1 (8)	26.4 (39)	34.6 (85)	36.8 (67)	74.2 (23)	50.0 (3)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square,  $df = 7$ ;  $p < .001$ . Cramer's  $v = .227$ .

Table 10

Percentages of Graduates and Nongraduates as a Function of Heart Rate Levels Following the Harvard Step Test, Fast Cadence<sup>a</sup>

Graduate status	Not tested	Heart rate* (beats/half-minute after 30 seconds rest)						
		30-39	40-49	50-59	60-69	70-79	80-89	90-99
Percentage of graduates	50.4 (129)	20.0 (1)	75.0 (33)	71.5 (118)	64.8 (190)	63.5 (80)	21.4 (3)	33.3 (1)
Percentage of nongraduates	49.6 (127)	80.0 (4)	25.0 (11)	28.5 (47)	35.2 (103)	36.5 (46)	78.6 (11)	66.7 (2)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square,  $df = 7$ ;  $p < .001$ . Cramer's  $v = .208$ .

Table 11

Percentages of Graduates and Nongraduates as a Function of Performance Levels on Push-ups in the ARI<sup>a</sup> Physical Fitness Test<sup>b</sup>

Graduate status	Not tested	Level of performance* (number completed in 1-minute period)						
		20-29	30-39	40-49	50-59	60-69	70-79	80-89
Percentage of graduates	50.2 (128)	48.7 (19)	58.5 (93)	67.1 (173)	71.8 (94)	76.5 (39)	66.7 (8)	100.0 (1)
Percentage of nongraduates	49.8 (127)	51.3 (20)	41.5 (66)	32.9 (85)	28.2 (37)	23.5 (12)	33.3 (4)	0.0 (0)

<sup>a</sup>Army Research Institute.

<sup>b</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square,  $df = 7$ ;  $p < .001$ . Cramer's  $v = .187$ .

Table 12

Percentages of Graduates and Nongraduates as a Function of Performance Levels on Chin-ups in the ARI<sup>a</sup> Physical Fitness Test<sup>b</sup>

Graduate status	Not tested	Level of performance* (number completed in 1-minute period)							
		0-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23
Percentage of graduates	53.9 (171)	50.0 (5)	47.5 (28)	59.2 (113)	69.9 (128)	71.6 (63)	78.6 (33)	85.7 (12)	100.0 (2)
Percentage of nongraduates	46.1 (146)	50.0 (5)	52.5 (31)	40.8 (78)	30.1 (55)	28.4 (25)	21.4 (9)	14.3 (2)	0.0 (0)

<sup>a</sup>Army Research Institute.

<sup>b</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square,  $df = 8$ ;  $p < .001$ . Cramer's  $v = .200$ .

strength of that relationship is greater with measurements on these events as predictors than with the point scores of the preceding tables. Tables 9 through 12 show that values of Cramer's  $V$  range from .187 to .227 for the ARI events, somewhat higher than those for the APFT scores. While the attenuating effects of prior selection on physical fitness are likely to influence these correlations, these fitness measures, having been taken by the experimenters the day before training began, should be more precise and yield more accurate representations of the true relationship.

For these data to be useful in setting cutoff scores for entry into Ranger training, the total distribution of scores on both the push-ups and the chin-ups events for all those individuals who eventually graduated from Ranger School are contained in Appendix B. The tables in that appendix show all the individuals who scored at a given level of repetitions in those events as well as the cumulative percentage of all individuals who scored at or above that given level.

### Injuries in Ranger Training

Training Phase and Activity When Injured. Self-reports of injury during Ranger training are tabulated in Table 13 and broken down according to the training phase and the training activities within that phase during which they occurred. The table shows that some activities, such as Hand-to-Hand Combat, occur only in certain phases of training (Fort Benning phase for Hand-to-Hand) so that zero injuries in some phases indicates that the activity does not appear in the training schedule. Other activities, such as Run, may be scheduled as a discrete activity only in one phase (Fort Benning) but may be part of other activities, such as a patrol in Florida, so that some individuals may have been hurt while running on patrol and reported it as a consequence.

The data show that Hand-to-Hand was the activity that produced the greatest percentage of injuries during the Fort Benning phase of training, whereas patrolling produced the highest percentage of injuries for each succeeding phase. The highest percentage of injuries for the entire course came during the Fort Benning phase (52.5%). The Fort Benning phase is followed by the Mountain phase at 35.5% and the Florida phase at 29.1%.

Training Phase and Body Area Injured. Table 14 breaks out the percentage of injuries involving various areas of the body by the phase of training in which they occurred. The table shows that the knee was most often injured at Fort Benning; the foot was the most common casualty in the mountains and in Florida. Note that the percentage of individuals reporting each injury for each phase will not sum to 100% because any individual could report more than one injury per phase and, in fact, many of them did so.

### Physical Fitness Variables and Injury

Physical Fitness and Self-Report of Injury. Table 15 shows physical fitness as measured by the events from both the APFT and the ARI Physical Fitness Test and the self-reports of injury in each phase. Only those correlations significantly greater than zero are listed, along with, in parentheses, the number of cases involved in the calculations. The table shows that few of the

Table 13

Injury Reports by Phase and Activity of Training

Activity	Phase of training					
	Fort Benning		Mountain		Florida	
	Percent injured	Number injured	Percent injured	Number injured	Percent injured	Number injured
Run	31.1	89	0.0	0	4.7	6
Hand-to-Hand	49.3	141	0.0	0	0.0	0
Airdrop	10.8	31	2.8	6	8.5	11
Mountaineering	0.7	2	29.4	63	2.3	3
Patrol	18.5	53	62.1	133	61.2	79
Confidence Course	5.6	16	0.0	0	0.0	0
Small Boat Operations	0.0	0	0.0	0	2.3	3
Helicopter Rappelling	0.3	1	0.0	0	0.0	0
Slide for Life/ Log Walk/ Rope Drop	2.4	7	0.0	0	0.0	0
Other	19.2	55	16.4	35	25.6	33
Totals for Phase	52.5	286	35.5	214	29.1	129

Table 14

Injury Reports by Phase of Training and Body Area Injured

Area	Phase of training					
	Fort Benning		Mountain		Florida	
	Percent with this injury	Number with this injury	Percent with this injury	Number with this injury	Percent with this injury	Number with this injury
Foot	22.0	63	32.2	69	51.2	66
Ankle	26.2	75	26.2	56	18.6	24
Lower leg	8.7	25	4.7	10	6.2	8
Knee	37.1	106	26.6	57	16.3	21
Thigh	4.9	14	2.8	6	1.6	2
Hip	2.4	7	1.9	4	2.3	3
Lower back	9.4	27	7.5	16	3.9	5
Upper back	3.1	9	2.8	6	2.3	3
Neck	2.0	6	2.3	5	1.6	2
Shoulder	15.0	43	5.6	12	2.3	3
Arm	4.2	12	3.3	7	3.9	5
Heat injury	1.0	3	0.0	0	1.6	2
Other	21.7	62	25.7	55	22.5	29

Note. Percent injured for all activities within each phase of training will not sum to 100% since individuals could report more than one injury per phase.

test events are related to injury reports. The largest correlation coefficient on the table is .173 for the relationship between points scored in the Sit-up event of the Advanced Physical Fitness Test and the report of injuries in Florida.

Table 15

Statistically Significant Correlations Between Physical Fitness Variables and Self-Reports of Injury From Each Phase of Training<sup>a</sup>

Event	Phase of training when injured		
	Fort Benning	Mountain	Florida
Advanced PFT <sup>b</sup>			
Crawl	--	--	--
Sit-ups	--	--	.173 (261)**
Ladder	--	--	--
Run, Dodge, and Jump	-.160 (327)**	--	.120 (253)*
2-Mile Run	.115 (334)*	--	--
ARI PFT			
Step Test, Slow	--	--	--
Step Test, Fast	--	--	-.105 (374)*
Push-ups	--	--	--
Chin-ups	--	--	--

<sup>a</sup>The numbers in parentheses are the numbers of cases involved in calculations of correlation coefficients.

<sup>b</sup>Physical Fitness Training.

\*Pearson  $r$ , Significance  $p < .050$ .

\*\*Pearson  $r$ , Significance  $p < .010$ .

To inquire further into the relationships demonstrated in Table 15, the data were recast in terms of point categories in the same manner as is shown in previous tables. The only two test events which produced significant distributions of injured individuals across score levels were Sit-ups and Run, Dodge, and Jump, which were also the strongest predictors from Table 15. These recast data are displayed in Tables 16 and 17. The data in these tables are the percentage of individuals scoring in those categories who subsequently became injured during the phase of training indicated.

Table 17 shows that the groups of individuals scoring fewer points on Sit-ups in the Advanced Physical Fitness Test also suffered greater percentages of injured individuals during the Florida phase of training. Paradoxically, the reverse is true for Run, Dodge, and Jump (Table 16): The more points that were scored in that event, the higher the percentage of injured

individuals during the Fort Benning phase. This is indicated also in Table 16 by the minus sign in front of the correlation coefficient relating Run, Dodge, and Jump to injury at Fort Benning. This result will have to be interpreted by reference to the unique nature of the Run, Dodge, and Jump event and the particular physical and body style possessed by those who do well in it. Perhaps the possibly slighter build of the quicker men in this event is slightly less resistant to the wear of Ranger training than that of heavier but slower men.

Table 16

Percentages of Students Reporting Injuries or not at Fort Benning as a Function of Score Levels on Run, Dodge, and Jump<sup>a</sup>

Injury status	No scores	Level of performance*							
		30-39	40-49	50-59	60-69	70-79	80-89	90-99	100
Percentage injured	52.3 (114)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	35.9 (14)	54.3 (50)	52.2 (71)	66.1 (37)
Percentage not injured	47.7 (104)	100.0 (1)	0.0 (0)	0.0 (0)	100.0 (3)	64.1 (25)	45.7 (42)	47.8 (65)	33.9 (19)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square,  $df = 6$ ;  $p = .043$ . Cramer's  $V = .155$ .

Table 17

Percentages of Students Reporting Injuries or not in Florida as a Function of Score Levels on Sit-ups<sup>a</sup>

Injury status	No scores	Level of performance*						
		40-49	50-59	60-69	70-79	80-89	90-99	100
Percentage injured	31.3 (57)	100.0 (1)	0.0 (0)	50.0 (3)	46.2 (12)	29.4 (15)	28.7 (27)	16.9 (14)
Percentage not injured	68.7 (125)	0.0 (0)	0.0 (0)	50.0 (3)	53.8 (14)	70.6 (36)	71.3 (67)	83.1 (69)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square,  $df = 6$ ;  $p = .032$ . Cramer's  $V = .177$ .

Physical Fitness and Medical Drops from the Course. The relationships considered to this point involved an individual's level of physical fitness and the self-report of whether the enrollee sustained any injury, however slight, in training. Many of these injuries were not reported to medical personnel and most did not cause the student to lose any training time. However, as was shown in Table 2, during the period of this research, 130 individuals developed medical problems (injury or illness) serious enough to cause their elimination from the Ranger Course.

Table 18 presents data from all enrollees in the course, including those who passed, those who were dropped for medical reasons, and all other groups from Table 2. The data are percentages of the total enrollment who became medical drops, broken down by heart rate category based on the 150-second measurement from the fast cadence period of the Harvard Step Test. In this table, as in previous ones showing heart rate data, the highest levels of physical fitness are represented by the lowest heart rate categories.

Table 18

Percentages of Students Dropped for Medical Reasons or not from the Ranger Course as a Function of Heart Rate Levels Following the Harvard Step Test, Fast Cadence<sup>a</sup>

Medical status	Not tested	Heart rate*					
		(beats/half-minute after 15 seconds rest)					
		20-29	30-39	40-49	50-59	60-69	70-79
Medical drops	16.0 (41)	0.0 (0)	9.2 (8)	9.6 (28)	20.7 (49)	12.0 (3)	33.3 (1)
Other	84.0 (215)	100.0 (7)	90.8 (79)	90.4 (263)	79.3 (188)	88.0 (22)	66.7 (2)

<sup>a</sup>Numbers in parentheses are the numbers enrolled from each group.

\*Significance: chi-square,  $df = 6$ ;  $p = .007$ . Cramer's  $V = .140$ .

This table shows that, over the mid-range categories of heart rate--those for which there are a substantial number of individuals with scores--the percentage of medical drops increases as physical fitness decreases, up to a high of 20.7% for those individuals whose heart rates ranged from 50 to 59 beats per half minute. Beyond that point, the percentage of medical drops declines but the total number of enrollees at that fitness level has declined markedly, also, and the percentage may be less reliable than for the two prior categories.

This distribution of students eliminated from the course for medical reasons is statistically significant ( $p = .007$ ) and would not be expected from chance alone. Although the relationship is slight ( $V = .140$ ), it indicates that those who report to the course in poorer cardiovascular condition



are somewhat more likely to be dropped eventually for medical reasons than are other students.

It is pointed out, however, that these groups differed only on this 150-second, fast-cadence heart rate measure. There were no statistically significant differences for other Step Test measurements or for any of the events of the APFT.

#### DISCUSSION

The attrition rate by class from the Ranger Course during the period of this research ranged from a low of 23% to a high of 43% of the members of each class who failed to graduate on schedule and were either permanently relieved from training or turned back to a later class. These losses represent substantial portions of the membership of each class and attest to the fact that the Ranger Course is difficult to complete. There are, of course, a complex of reasons for that fact, but an obviously important reason is the difficulty created by the training's extremely strenuous and exhausting components. The data presented here relating physical fitness scores to graduate status suggest that many individuals report in to the course insufficiently prepared to meet the physical challenges that they will encounter. It may well be that both entering level physical fitness and completion of the course result from the force of more powerful motivational and personality variables that drive the successful individuals to prepare properly for challenges and to succeed at whatever they attempt. Nonetheless, whatever the underlying variables may be, physical fitness scores are representative of them and can be used to predict success at Ranger training.

Another reason why many students fail to graduate is that they become injured or ill at some time during the rugged training and either become immediate medical casualties or have their capacity to perform physical tasks so severely diminished that they eventually find themselves unable to keep up with their classmates. Relationships shown in these data between physical fitness and injury are not strong and, in some cases, are hard to interpret, as in Run, Dodge, and Jump. However, the data do show on some measures, as in Sit-ups and Heart Rate, that there is a greater likelihood of the less fit individual sustaining some sort of injury or experiencing serious illness during training than will his more fit colleagues.

Chance is probably the most important variable in determining the occurrence of injury. The man who is unfortunate enough to step into a hole while running in the woods at night may get hurt regardless of his overall physical condition or the strength of his legs and ankles. Slight to moderate relationships between fitness and injury have been noted here, however, even after selection of students into the course on physical fitness criteria. Staff should consider those relationships when revising the physical fitness test standards that govern entry of new students into the program. Relaxing the entry requirements could result in a perceptible increase in the rate of injuries.

Taken together, the relationship between physical fitness, on the one hand, and graduate status and the occurrence of injury on the other shows that the physical fitness levels of students when they report to the course

influence the number of trained men that the Ranger Department is able to graduate. If the Ranger training program remains unchanged, any relaxation of the physical fitness requirements of the course will result in a smaller percentage of Ranger students who graduate each year. In view of the \$15,000 estimated cost per student (Elliott, note 1), such a decrease would be expensive both in terms of the reduction of trained men and the loss of money spent without return.

REFERENCE NOTE

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APPENDIX A  
INJURY DATA QUESTIONNAIRE

CLASS # \_\_\_\_\_

1. NAME \_\_\_\_\_  
                    (Last)                                    (First)                                    (Middle)

2. SSN \_\_\_\_\_

3. Phase of training

- 01 \_\_\_\_\_ Benning Phase
- 02 \_\_\_\_\_ Mountain Phase
- 03 \_\_\_\_\_ Florida Phase

4. Have you been injured in any way during this phase of Ranger training?

- 01 \_\_\_\_\_ Yes
- 02 \_\_\_\_\_ No

5. Activity producing injury

- 01 \_\_\_\_\_ Run
- 02 \_\_\_\_\_ Hand-to-hand Combatives
- 03 \_\_\_\_\_ Airborne Drop
- 04 \_\_\_\_\_ Mountaineering
- 05 \_\_\_\_\_ Patrol
- 06 \_\_\_\_\_ Confidence Course
- 07 \_\_\_\_\_ Small Boat Operations
- 08 \_\_\_\_\_ Helicopter Rappelling
- 09 \_\_\_\_\_ Slide for Life/Log Walk/Rope Drop
- 10 \_\_\_\_\_ Other (explain) \_\_\_\_\_

6. How serious do you think the injury is?

- 01 \_\_\_\_\_ Not serious
- 02 \_\_\_\_\_ Slightly serious
- 03 \_\_\_\_\_ Serious
- 04 \_\_\_\_\_ Very serious
- 05 \_\_\_\_\_ Extremely serious

7. Did you report this injury:

- 01 \_\_\_\_\_ Yes
- 02 \_\_\_\_\_ No

8. Area(s) injured

- 01 \_\_\_\_\_ Foot
- 02 \_\_\_\_\_ Ankle
- 03 \_\_\_\_\_ Lower Leg
- 04 \_\_\_\_\_ Knee
- 05 \_\_\_\_\_ Thigh
- 06 \_\_\_\_\_ Hip
- 07 \_\_\_\_\_ Lower Back
- 08 \_\_\_\_\_ Upper Back
- 09 \_\_\_\_\_ Neck
- 10 \_\_\_\_\_ Shoulder
- 11 \_\_\_\_\_ Arm
- 12 \_\_\_\_\_ Heat Injury
- 13 \_\_\_\_\_ Other (explain) \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

9. Type of injury

- 01 \_\_\_\_\_ Muscle
- 02 \_\_\_\_\_ Bone
- 03 \_\_\_\_\_ Ligament or tendon
- 04 \_\_\_\_\_ Other (explain) \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

10. Disposition

- 01 \_\_\_\_\_ Continued Training
- 02 \_\_\_\_\_ Recycled
- 03 \_\_\_\_\_ Dropped from Training
- 04 \_\_\_\_\_ Profile (up to 1 year)
- 05 \_\_\_\_\_ Permanent Profile
- 06 \_\_\_\_\_ Other (explain) \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

# APPENDIX B

Table B-1

Numbers and Cumulative Percentages of Graduates Scoring at Each Level  
on Push-Ups in the ARI Physical Fitness Test

Number of push-ups	Number of graduates	Percentage completing at least this many
23	1	100.0
24	1	99.5
26	4	98.6
27	1	98.4
28	6	97.0
29	6	95.6
30	2	95.1
31	3	96.4
32	3	92.5
33	10	91.2
34	12	87.4
35	13	84.3
36	9	82.2
37	14	78.9
38	13	75.9
39	9	73.8
40	26	67.7
41	13	64.6
42	23	59.3
43	15	55.7
44	13	52.7
45	25	46.8
46	12	44.0
47	22	38.9
48	16	35.1
49	8	33.3
50	20	28.6
51	7	26.9
52	11	24.4
53	10	22.0
54	14	18.7
55	8	16.9
56	3	16.2
57	7	14.5
58	8	12.6
59	6	11.2
60	4	10.3

Table B-1 (Continued)

Number of push-ups	Number of graduates	Percentage completing at least this many
61	7	8.7
62	7	7.0
63	1	6.8
64	3	6.1
65	4	5.2
66	3	4.4
67	7	2.8
68	2	2.6
69	2	2.1
70	2	1.6
71	1	1.4
72	2	0.9
73	1	0.7
76	1	0.5
78	1	0.2
80	1	
Not tested	<u>128</u>	
Total	555	



Table B-2

Numbers and Cumulative Percentages of Graduates Scoring at Each Level  
on Chin-ups in the ARI Physical Fitness Test

Number of chin-ups	Number of graduates	Percentage completing at least this many
2	5	100.0
3	6	97.1
4	6	95.6
5	16	91.4
6	23	85.4
7	41	74.7
8	49	62.0
9	44	50.5
10	52	37.0
11	32	28.6
12	29	21.1
13	26	14.3
14	8	12.2
15	16	8.1
16	11	5.2
17	6	3.6
18	5	2.3
19	3	1.6
20	4	0.5
21	1	0.1
22	1	
Not tested	<u>171</u>	
Total	555	